Appendix B2 - Ecological Risk-Based Preliminary Remediation Goal (PRG) Derivation

1.0 Introduction

Preliminary Remediation Goals (PRGs) in this Feasibility Study (FS) are based on risk-based toxicity reference values (TRVs) identified in the Portland Harbor Baseline Ecological Risk Assessment (BERA, Windward Environmental 2013), on the results of site-specific sediment toxicity tests presented in the BERA, and on the dietary exposures identified in the BERA. Ecological PRGs have been developed for sediment, surface water, and pore water. A summary of the ecological risk-based PRGs is presented in Table B2.

1.1 Sediment PRGs Based on Direct Exposure

Two types of sediment PRGs were developed for protection of ecological receptors via direct contact:

- PRGs expressed as dry weight (dw) contaminant concentrations in sediment.
- Empirical, site specific toxicity-based PRGs, expressed in terms of a maximum allowable percent reduction in either survival or biomass

Benthic Invertebrate PRGs

Sediment PRGs are developed for three benthic organisms: clams, crayfish, and worms. The values were derived from the benthic tissue-residue LOAEL TRVs in Table 6-27 of the BERA (Windward 2013), divided by site-specific biota-sediment accumulation regressions (BSARs) to obtain the protective sediment concentrations. Site-specific BSARs were developed and presented in Tables 4-1, 4-2, and 4-3 of the *Bioaccumulation Modeling Report* (Windward 20XX). The L2 SQV values from the BERA Table 6-11 were used for the benthic values representing the Logistic Regression Model (LRM). The PEC values in Table B2 are from McDonald et al (2000) presented in Table 6-18 of the BERA.

Tissue Residue-based PRGs

PRGs protective of fish are sediment concentrations calculated such that contaminant concentrations in whole body fish will be less than those linked to ecologically significant adverse effects directly on fish (but not secondary effects on consumers of exposed fish). BSARs were developed and presented in Tables 4-4 and 4-5 of the *Bioaccumulation Modeling Report* (Windward 20XX) for fish with small home ranges (sculpin and small mouth bass). Biota-sediment accumulation factors (BSAFs) were developed and presented in Table 4-6 of the *Bioaccumulation Modeling Report* (Windward 20XX) for large home-range fish with large home ranges (black crappie, brown bullhead, carp, lamprey, largescale sucker, northern pikeminnow, and peamouth). For those contaminants where site-specific biota-sediment accumulation factors (BSAFs) or BSARs could not identify relationships between sediment and tissue concentrations, a nationwide theoretical BSAF of 4.0 was used for hydrophobic organic chemicals (U.S. Army Corps of Engineers 2003, Appendix G).

Empirical Site Specific Sediment Toxicity Test Based PRGs.

Sediment toxicity test based TRVs are expressed as 1) the minimum allowable percent survival or 2) the minimum percent biomass relative to survival or biomass in the laboratory negative control response for each of four sediment toxicity test endpoints. Toxicity test

PRGs are applied in a single endpoint specific basis; failure to meet any one of the criteria presented below is considered indicative of unacceptable risk.

- *Chironomus dilutus* survival must be greater than 84 percent
- *Chironomus dilutus* biomass must be greater than 82 percent of control sample biomass
- *Hyalella azteca* survival must be greater than 79 percent
- *Hyalella azteca* biomass must be greater than 59 percent of control sample biomass

The PRGs for minimum allowable survival or biomass were derived from a site and toxicity test-specific approach for identifying reductions in survival or biomass greater than what would be expected at relatively contaminant-free portions of Portland Harbor. This "reference envelope" approach, is described in detail in Section 6 of the final BERA and its associated attachments. Failure to meet a toxicity test-based PRG, is defined in terms of both the absolute magnitude of the survival or biomass reduction, and the reduction must differ from the control response criterion with statistical significance.

Level 1 (low toxicity) adverse effect levels from site-specific sediment toxicity tests in the BERA were not used to derive sediment PRGs because either the percentage reduction in survival or biomass from the toxicity tests overlapped the allowable control mortality or biomass reductions in the ASTM and EPA sediment toxicity testing methodology acceptability criteria, or the Level 1 reductions in survival or biomass from control sample survival and biomass were not statistically significantly different.

Benthic risk areas were identified based on multiple lines of evidence including numerical sediment PRGs, transition zone water concentrations compared to water quality criteria for the protection of aquatic life, and site specific toxicity testing. Sediment toxicity was considered the primary line of evidence for identifying benthic risk areas, and areas where sediment PRGs were exceeded but no toxicity was observed were not included as benthic risk areas.

1.2 Sediment PRGs Based on Ingestion of Biota (prey)

Sediment PRGs protective of the BERA avian and mammalian assessment endpoints from dietary ingestion were estimated using either the Arnot and Gobas food web model as modified for Portland Harbor (Windward 2015), or the use of BSAFs. Because a multi-species diet was used to evaluate risk associated with the dietary pathway, a range of PRGs were developed. PRGs based on prey ingestion were calculated using the following general formula: .

$$PRG_{sed} = \left[\frac{\left(\dfrac{TRV_{dietary}}{CR} \right)}{BSAF \times f_{lipid}} \right] \times f_{oc} \times CF$$

Where:

    PRG_{sed} = Preliminary remediation goal in sediment for a contaminant (µg/kg or mg/kg dry weight sediment)

TRV$_{dietary}$	=	Toxicity reference value for contaminant in the diet if the target ecological receptor (mg/kg or mg/kg BW-day), where BW us the body weight of the target receptor
CR	=	Consumption rate of prey items (kg/day or kg/kg body weight-day)
f$_{lipid}$	=	Decimal fraction of the lipid content of prey (unitless)
BSAF	=	Biota-sediment accumulation factor from sediment to prey (unitless)
f$_{oc}$	=	Decimal fraction of the organic carbon content of sediment (unitless)
CF	=	Units conversion factor as needed

BASFs and BSARs (as appropriate) are presented in Section 4 of Windward 2015, avian and mammalian dietary TRVs are presented in Tables 8-9 and 8-10, respectively, of the final BERA (Windward 2013). PRGs were developed for chlorinated pesticides, total PCBs, and specific dioxin/furan congeners using the food web model. The target prey tissue concentration was calculated as a weighted mean based on the prey-consumption portions for each target species presented in Table 8-6 of the Final Portland Harbor BERA. Oregon human health ambient water quality criteria (DEQ 2011) for consumption of water and organism were used for the contaminant concentration in water. The goal-seek function in Excel was then used to calculate a sediment concentration that resulted in the weighted mean target tissue concentration for each species presented in Table 8-11 and 8-13 of the Final BERA, and assuming a LOAEL endpoint

1.3   Sediment PRGs for Piscivorous Bird Egg

Parental contaminant levels accumulated from the diet of birds are in turn deposited in their eggs via maternal transfer. Sediment PRGs for contaminants in bird egg tissue were calculated for PCBs, dioxins/furans, DDx and DDE. Sediment PRGs from the bird egg line of evidence in the BERA were calculated as follows:

$$PRG_{sed} = \left[\frac{\left(\dfrac{TRV_{bird\ egg\ tissue}}{BMF} \right)}{BSAF \times f_{lipid}} \right] \times f_{oc} \times CF$$

Where:

PRG$_{sed}$	=	Preliminary remediation goal in sediment for a contaminant (µg/kg or mg/kg dry weight sediment)
TRV$_{bird\ egg\ tissue}$	=	Toxicity reference value for a contaminant in the eggs of the target avian receptor (mg/kg)
BMF	=	Prey to egg biomagnification factor (unitless)
f$_{lipid}$	=	Decimal fraction of the lipid content of prey (unitless)
BSAF	=	Biota-sediment accumulation factor from sediment to prey (unitless)
f$_{oc}$	=	Decimal fraction of the organic carbon content of sediment (unitless)
CF	=	Units conversion factor as needed

Due to the limited number of dioxin/furans analyses of fish tissue, a number of assumptions were needed to calculate the target dioxin prey- tissue concentration. Although 90 percent of the osprey diet at Portland Harbor consists of largescale sucker, pikeminnow, no tissue

analyses of these species were performed for dioxin/furan congeners. Thus, dioxin concentrations in osprey prey species were extrapolated from analytical results from carp, smallmouth bass and brown bullhead. Portland Harbor fish species in the osprey diet for which dioxin tissue results are available. These three species account for 6, 2 and 2 percent of the osprey diet, respectively. Scaling these proportions 100 percent of the diet yields a diet of 60 percent carp, 20 percent bass, and 20 percent bullhead.

2.0   References

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